CHAPTER-6

CONCLUSIONS

6.1 GENERAL

A smart grid architecture requires its complete automation. Distribution is the most challenging part of the power system. Concept of smart grid will be incomplete without automatic monitoring, control and protection of distribution networks. Complete automation of distribution networks seems feasible through smart metering scheme. Smart meters at consumer premises may be made capable to interface with supply utilities in bidirectional fashion. Informations obtained from smart meters may be sent to control centre through communication protocol. Phasor Measurement Units (PMUs) may be placed at the substation and distribution transformers and PMU measurements may also be sent to control centre. Control centre may have various application softwares for real-time monitoring, control, and protection of distribution networks.

This thesis has explored the feasibility of implementing smart metering scheme for automatic monitoring, control and protection of distribution networks. A two-level control architecture consisting of master controller at the main substation receiving power from supply utility, and local controller at distribution transformers has been proposed. All local controllers are able to interface with smart meters at consumer premises in bidirectional fashion through Information and Communication Technology (ICT), and master controller is able to interface with local controllers in bidirectional fashion through ICT. PMUs have been proposed to be placed at the main substation and distribution transformers for time stamped measurements. PMU measurements are communicated to controllers through IEC-61850 communication protocol.

The objective of this chapter is to summarize main contributions of this thesis and provide suggestions for further research in this direction. Some of the important findings of the thesis are presented below.

6.2 SUMMARY OF IMPORTANT FINDINGS

In Chapter 2, a survey of a smart metering project by Kalkitech's in south area of Delhi has been presented. This project considers transmitting data from smart meters to Central Data Collection System (CDCS) through SYNC 2000 and SYNC 5000. The benefits of smart meter over a special energy meter has been studied through case studies performed.

Chapter 3 proposed a two level control architecture for automatic monitoring, control, and protection of distribution networks. Master controller placed at the main substation decides load disconnection/reconnection based on available power from supply utility. Local controller placed at distribution transformers perform various monitoring, control, and protection functions such as protection of feeder from overcurrent, balancing of three phases, power theft detection and elimination. All local controllers are capable to interface with smart meters at consumer premises in bidirectional fashion. Master controller is capable to interface with all local controllers in bidirectional fashion. Effectiveness of proposed two-level control architecture was tested on a radial distribution network using case studies performed on its MATLAB/SIMULINK model. Results obtained on MATLAB/SIMULINK model was validated on eMEGASim® OP5600 OPAL-RT real-time simulator.

In Chapter 4, a simulation model of PMU in MATLAB as well as in LABVIEW was proposed for estimation of phasors using Discrete Fourier Transform (DFT). It was observed through case studies that MATLAB model was faster in estimation of phasors as compared to LABVIEW model.

Chapter 5 proposed two level control architecture of distribution network with PMUs placed at the main substation as well as at distribution transformers. Estimated voltage and current phasors together with frequency were transmitted to master controller and local controllers through IEC-61850 communication protocol. Automatic monitoring, control, and protection of radial distribution network was proposed based on informations received by controllers from PMUs and smart meters. MATLAB/SIMULINK model of PMU developed in Chapter 4 was considered for estimation of phasors. Simulations were carried out on the test system on an eMEGASim® OP5600 OPAL-RT real-time simulator.

6.3 SCOPE FOR FUTURE RESEARCH

As consequence of the investigations carried out in this thesis, the following aspects re being suggested for further research work in this area.

1. Present work has considered automatic monitoring, control, and protection of radial distribution networks through smart metering scheme. Further research may be carried out in considering meshed distribution networks for the automatic monitoring, control, and protection through smart metering scheme.
2. Present work has considered IEC-61850 communication protocol for transmission of data. Further attempt is required in seeing impact of other communication protocols in transmission of data from PMUs to controllers.
3. IEC-61850 communication protocol results may be verified by interfacing with relays.
4. Present work has used estimated phasors from a PMU model developed in MATLAB. Further effort is required in validating simulations carried out in this thesis through measurements performed on hardware PMU.
5. Present work has considered wired network for transmission of data. Further effort is required in investigating transmission of data through wireless system.